THIN-FILM STRUCTURE PROCESSING DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to processing a thin-film structure.

Description of the Related Art

In the prior art, a cleaning device and a method thereof are known. It is an object of the cleaning device of the present invention and method thereof to remove impurities such as organic materials, acids, hydrocarbons, and metallic thin-film adhered precision components such as semiconductor wafer, electronic substrate, GMR head (Giant Magneto Resistive Head), or connector of an electronic component etc. (refer to Japan Patent Laid Open No. 2001-277116)

There is no device in the prior art for grinding the uneven surface of the thin-film structure such as semiconductor material, formed at the point of processing, or the flare, solidly fixed to the base of the thin-film layer of the semiconductor material. Therefore, a resist peeling device, a dry-etching device, or grinding device is additionally required, thereby increasing the cost.

SUMMARY OF THE INVENTION

In the first aspect of the present invention, the thin-film structure processing device for processing a thin-film structure formed on a substrate comprises:

a liquefied high-pressure inert gas storage section storing the liquefied high-pressure inert gas, and

a nozzle section for discharging liquefied inert gas stored by said liquefied high-pressure inert gas storage section into atmosphere pressure jetting jet flow including dry ice particles of inert gas to said thin-film structure, and wherein said nozzle section has the nozzle structure capable of providing a jet flow strong enough for grinding the thin-film comprising said thin-film structure by jetting the jet flow of said inert gas to the thin-film structure.

In the second aspect of the present invention, the nozzle section comprises:

the first gas pathway for said inert gas, and

the second gas pathway adjacent to at least one portion of said first gas pathway, and wherein the dew-condensation prevention gas for preventing dew-condensation of said first gas pathway and the discharging end of the first gas pathway flows through said second gas pathway.

In the third aspect of the present invention, the thin-film structure processing device comprises:

the liquefied high-pressure inert gas storage section storing the liquefied high-pressure inert gas,

the abrasive storage section storing abrasive, and

the nozzle section for jetting jet flow including dry ice particles of inert gas generated by discharging liquefied inert gas stored by said liquefied high-pressure inert gas storage section into atmosphere pressure and the abrasive stored by said abrasive storage section, to said thin-film structure, and wherein said nozzle section has the nozzle structure capable of forming the jet flow strong enough for grinding the thin-film composing said thin-film structure by jetting the jet flow of said inert gas and said abrasive to the thin-film structure.

Moreover, in the nozzle structure, the end of said third gas pathway

is disposed to the rear end of the portion wherein carbon dioxide flows fast, so that the air pressure of the portion, wherein carbon dioxide flows, drops extremely fast, and the abrasive is taken in from the end of the gas pathway to the inside of the nozzle and discharged to the inside of the nozzle in the form of a mist. At the point of discharging, the abrasive, attached or unattached to carbon dioxide, is jetted to a substrate by the pressure of the carbon dioxide, thereby cleaning the thin-film structure.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of the first embodiment of the present invention.

Fig. 2 is a cross-sectional view of the nozzle structure of the first embodiment of the present invention.

Fig. 3 is an illustration of the flare.

Fig. 4 is the first illustration of forming the flare.

Fig. 5 is the second illustration of forming the flare.

Fig. 6 is the third illustration of forming the flare.

Fig. 7 is the first cross-sectional view of the nozzle structure of the second embodiment of the present invention.

Fig. 8 is a schematic view of the fifth embodiment of the present invention.

Fig. 9 is the first cross-sectional view of the nozzle structure of the fifth embodiment of the present invention.

Fig. 10 is the second cross-sectional view of the nozzle structure of the fifth embodiment of the present invention.

Fig. 11 is the second cross-sectional view of the nozzle structure of the first embodiment of the present invention.

Fig. 12 is the second cross-sectional view of the nozzle structure of

the second embodiment of the present invention.

Fig. 13 is the third cross-sectional view of the nozzle structure of the fifth embodiment of the present invention.

Fig. 14 is the first cross-sectional view of the nozzle structure of the fourth embodiment of the present invention.

Fig. 15 is the second cross-sectional view of the nozzle structure of the fourth embodiment of the present invention.

Fig. 16 is a cross-sectional view of the nozzle structure of the fifth embodiment of the present invention.

Fig. 17 is the first schematic view of the other embodiment of the present invention.

Fig. 18 is the second schematic view of the other embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments of the present invention will be described hereinafter.

The first embodiment of the present invention will be described with the use of drawings.

As shown in Fig. 1, the thin-film structure processing device (0101) comprises the liquefied high-pressure inert gas storage section (0102) and the nozzle section (0103).

An example of the liquefied high-pressure inert gas storage section includes a high-pressure gas cylinder. The liquefied high-pressure inert gas corresponds to inert gas stored in a high-pressure state in order to keep the liquid state thereof at normal temperature. Examples of the inert gas include dioxide gas, argon, and nitrogen.

The root portion of the nozzle section is connected to said liquefied

high-pressure inert gas storage section via the connecting tube (0104), and another end is disposed in atmosphere pressure (0105). Moreover, said nozzle section has the nozzle structure capable of forming the jet flow strong enough for grinding the thin-film composing said thin-film structure such as semiconductor material which is an object of processing.

Specifically, the nozzle having cross-sectional structures as shown in Figs. 2 and 11 are assumed. The nozzle section (0201 and 1101) has a hollow structure as shown in Figs. 2 and 11, the root portion of the nozzle section is connected to said liquefied high-pressure inert gas storage section via the connecting tube (0202 and 1102), and the inert gas is injected. Another end thereof is disposed in atmosphere pressure, and discharges the dry ice particles of inert gas (0203 and 1103).

Next, an operation process of said thin-film structure processing device will be described. The inert gas stored in said liquefied high-pressure inert gas storage section arrives at the nozzle section via the connecting tube. The inert gas that has arrived at the nozzle section is disposed in atmosphere pressure of another end. At this point, the inert gas liquefied by high-pressure partially evaporates or solidifies as pressure drops to normal. The solidified inert gas becomes dry ice particles. By jetting the jet flow including these dry ice particles to the thin-film structure, the uneven surface of the thin-film structure and the flare are processed.

Here, the “thin-film structure” corresponds to a structure having layers of thin-film such as silicon material which is a material of a semiconductor, oxide material, compound material, and metal material etc. Moreover, examples of the thin-film structure include resist, oil film, and organic film such as wax and adhesive etc.

Moreover, “processed” corresponds to partial or total destruction of

the portion of the structurally connected thin-film structure, caused by the impact of the jet flow of the dry ice particles of the inert gas.

For example, it includes grinding the uneven surface of the thin-film structure of a precision component such as silicon material which is a material of a semiconductor, oxide material, compound material, and metal material etc., like that of the surface of a mirror.

Moreover, it becomes usable to grind or remove the flare formed at etching of a semiconductor material. Here, the "flare" corresponds not to a burr but to a flare solidly fixed to the base of the thin-film of the semiconductor material. Fig. 3 is an illustration of the flare formed on the thin-film such as oxide film or metal film formed on the substrate such as silicon or gallium arsenide. Figs. 4, 5, and 6 illustrate the process of the formation of said flare. Generally, as shown in Fig. 4, in order to form an electrical circuit on a semiconductor substrate, a thin-film such as oxide film or metal film is formed on the substrate such as silicon or gallium arsenide and is coated with the photo resist material. Next, the ion beam is irradiated to the semiconductor substrate coated with the photo resist material from above, thereby removing the uncoated thin-film with the photo resist material. After that the photo resist material is removed by etching. In cases where the ion beam is irradiated, it is ideal that the molecules of the thin-film material are spattered to outside the photo resist material as shown in Fig. 5. However, in fact, all the molecules of the photo resist are not spattered to outside the photo resist, and some of them attach to side of the photo resist. The portion surrounded by the dotted-line in Fig. 6 will become the flare, thereby forming the flare, about 1 μm in height and 0.2 μm in width, solidly fixed to the base of the thin-film of the semiconductor material as shown in Fig. 3. This is the process of forming the flare formed on the semiconductor material.

The function of the liquefied high-pressure inert gas nozzle is described below: the liquefied high-pressure inert gas is compressed and transported to inside the nozzle and flows through the narrow portion of the nozzle tube, thereby generating a higher flow rate thereof. Therefore, the jet flow is discharged to the mouth of the nozzle.

At this point, the liquefied high-pressure inert gas jetted in the form of mist transforms itself to ultra-fine dry ice particles by adiabatic expansion, thereby enabling the grinding of the thin-film, the burr and the flare on the surface of the substrate. Thus, the nozzle has a structure capable of implementing such a function.

The second embodiment of the present invention relates to the thin-film structure processing device of the first embodiment of the present invention having the nozzle function for preventing the discharging end of the first embodiment of the present invention from having dew-condensation of vapor in atmosphere pressure.

The second embodiment of the present invention will be described with the use of drawings.

The detail of the nozzle structure is illustrated in Figs. 7 and 12.

As shown in Figs. 7 and 12, the nozzle section (0701 and 1201) comprises the first gas pathway and the second gas pathway (0702 and 1202).

The first gas pathway is used for passage of insert gas.

Here, the inert gas corresponds to liquefied high-pressure inert gas stored in the "liquefied high-pressure inert gas storage section" of the first embodiment of the present invention. Examples of the inert gas include carbon dioxide, argon, and nitrogen.

Specifically, the first gas pathway having cross-sectional structures as shown in Figs. 7 and 12 are assumed. The first gas pathway has a hollow structure as shown in Figs. 7 and 12, the root portion of the nozzle section

is connected to said liquefied high-pressure inert gas storage section via the connecting tube (0704 and 1204), and the inert gas is injected. Another end thereof is disposed in atmosphere pressure, and discharges the dry ice particles of inert gas (0705 and 1205).

The second gas pathway is adjacent to at least one portion (possibly all portions) of said first gas pathway as shown in Figs. 7 and 12.

The dew-condensation prevention gas (0706 and 1206) for preventing dew-condensation of said first gas pathway and the discharging end of the first gas pathway flows through the second gas pathway. The dew-condensation prevention gas injected with the inert gas jetted from the first gas pathway is jetted from the discharging end of the nozzle section via the second gas pathway. The dew-condensation prevention gas, injected into the second gas pathway at normal temperature, flows at high-speed, thereby preventing the cooling of the nozzle section and dew-condensation of vapor in atmosphere pressure. Here, examples of dew-condensation include not only vapor liquefying and transforming to the state of dew but also solidifying and transforming to the state of dry ice. Moreover, some of jetted dew-condensation prevention gas picks up the inert gas and the other permeates in the atmosphere pressure, thereby preventing the dew-condensation of the vapor in atmosphere pressure and growth of the dry ice particles causing distraction of the object of processing.

Next, an operation process of said thin-film structure processing device, using the nozzle structure of the second embodiment of the present invention, will be described. The inert gas stored in said liquefied high-pressure inert gas storage section arrives at the nozzle section via the connecting tube. The inert gas that has arrived at the nozzle section is disposed in the atmosphere pressure of another end. At this point, the inert gas liquefied by high-pressure partially evaporates or solidifies as

pressure drops to normal. The solidified inert gas becomes dry ice particles. At this point, use of carbon dioxide as the inert gas causes rapid temperature reduction at the discharging end of the nozzle section. Therefore, in cases where the vapor is contained in atmosphere pressure, the vapor in the atmosphere pressure condenses the periphery of the discharging end of the nozzle, thereby disabling the nozzle. Therefore, the dew-condensation prevention gas is injected from the second gas pathway of the nozzle section. The dew-condensation prevention gas injected into the second gas pathway at normal temperature flows at high-speed, thereby preventing the cooling of the nozzle section and dew-condensation of vapor in atmosphere pressure. Moreover, some of the jetted dew-condensation prevention gas picks up the inert gas and the other permeates in atmosphere pressure, thereby preventing the dew-condensation of the vapor in atmosphere pressure and growth of the dry ice particles causing distraction of the object of processing. Thus, the dew-condensation of the vapor in atmosphere pressure is prevented. Moreover, by jetting the jet flow including the dry ice particles to the thin-film structure, the uneven surface of the thin-film structure and the flare are processed.

The third embodiment of the present invention relates to the thin-film structure processing device of the first embodiment of the present invention wherein nitrogen gas is used as the dew-condensation prevention gas.

The other characteristics of the third embodiment of the present invention are the same as described in the second embodiment of the present invention.

The fourth embodiment of the present invention relates to the thin-film structure processing device of the first embodiment of the present invention having the nozzle structure for removing static electricity of the inert gas discharged as the jet flow from the discharging end of the nozzle section

of the first embodiment of the present invention.

The fourth embodiment of the present invention will be described with the use of drawings.

The detail of the nozzle structure is illustrated in Figs. 14 and 15. As shown in Figs. 14 and 15, the nozzle section (1401 and 1501) comprises the first gas pathway and the third gas pathway (0403 and 1503).

Here, the inert gas corresponds to liquefied high-pressure inert gas stored in the liquefied high-pressure inert gas storage section of the first embodiment of the present invention. Examples of the inert gas include carbon dioxide, argon, and nitrogen.

Specifically, the first gas pathway having cross-sectional structures as shown in Figs. 14 and 15 are assumed. The first gas pathway has a hollow structure as shown in Figs. 14 and 15, the root portion of the nozzle section is connected to said liquefied high-pressure inert gas storage section via the connecting tube (1404 and 1504), and the inert gas is injected. Another end thereof is disposed in atmosphere pressure, and discharges the dry ice particles of inert gas (1405 and 1505).

The third gas pathway comprises a discharging end adjacent to the discharging end of said first gas pathway.

The liquefied nitrogen flows through said third gas pathway, and in order to remove static electricity of said inert gas, discharged as the jet flow from the discharging end of said first gas pathway, the discharging end of said third gas pathway jets said liquefied nitrogen in the form of mist. While the liquefied nitrogen in the form of mist arrives to the object of processing, some portion of it exists as liquefied nitrogen in the form of mist and the other portion of it evaporates to nitrogen gas, so that the particles of the liquefied nitrogen in the form of mist (1406 and 1506) absorb static electricity in atmosphere pressure. Moreover, most portions of the

liquefied nitrogen in the form of mist, which arrive to the object of processing, evaporate, thereby enabling dry-processing.

Moreover, liquefied argon may be substituted for said liquefied nitrogen.

Next, an operation process of said thin-film structure processing device using the nozzle structure of the fourth embodiment of the present invention will be described. The inert gas stored in said liquefied high-pressure inert gas storage section arrives to the nozzle section via the connecting tube. The inert gas that has arrived to the nozzle section is disposed in atmosphere pressure of another end. The particles of the inert gas are possible to be electrified. At this point, the liquefied nitrogen is injected from the third gas pathway and jetted in the form of mist from the discharging end of the nozzle section. While the liquefied nitrogen in the form of mist arrives to the object of processing, some portion of it exists as liquefied nitrogen in the form of mist and the other portion of it evaporates to nitrogen gas, so that the particles of the liquefied nitrogen in the form of mist absorbs static electricity in atmosphere pressure. Moreover, most portions of the liquefied nitrogen in the form of mist, which arrive to the object of processing, evaporate, thereby enabling dry-processing.

The fifth embodiment of the present invention relates to the thin-film structure processing device of the first embodiment of the present invention having the nozzle structure for attaching abrasive to the periphery of the dry ice particles of discharged inert gas of the first embodiment of the present invention.

The fifth embodiment of the present invention will be described with the use of drawings.

As shown in Fig. 8, the thin-film structure processing device (0801)

comprises the liquefied high-pressure inert gas storage section (0802), the nozzle section (0803), and the abrasive storage section (0806).

The liquefied high-pressure inert gas storage section is the same as described in the first embodiment of the present invention.

The root portion of the nozzle section is connected to said liquefied high-pressure inert gas storage section via the connecting tube (0804), and the other end is disposed in atmosphere pressure (0805). Moreover, said nozzle section has the nozzle structure capable of forming the jet flow strong enough for grinding the thin-film composing said thin-film structure such as semiconductor material which is an object of processing.

Specifically, the nozzle having cross-sectional structures as shown in Figs. 9, 10, and 13 are assumed. The nozzle section (0901, 1001, and 1301) has a hollow structure as shown in Figs. 9, 10, and 13, the root portion of the nozzle section is connected to said liquefied high-pressure inert gas storage section via the connecting tube (0902, 1002, and 1302), and the inert gas is injected. Another end thereof is disposed in atmosphere pressure, and discharges the dry ice particles of inert gas (0903, 1003, and 1303). Moreover, the abrasive (0904, 1004, and 1304) is injected from the mid-body of the nozzle section. The injected abrasive is compressed and transported to inside the nozzle by suction effect of negative pressure inside of the nozzle, attached to the surface of the dry ice particles of the inert gas before the discharging end of the nozzle section, and discharged therefrom. The abrasive particles (0905, 1005, and 1305) are attached on the surface of the discharged dry ice particles of the inert gas, so that the discharged dry ice particles of the inert gas increase the physical strength thereof.

Moreover, a nozzle having a cross-sectional structure, as shown in Fig. 16, may be used.

This nozzle structure further has the abrasive inlet as shown in Fig.

13 in addition to the nozzle structure of Fig. 12 as described in the second embodiment of the present invention.

The nozzle section (1601) has a hollow structure as shown in Fig. 16, the root portion of the nozzle section is connected to said liquefied high-pressure inert gas storage section via the connecting tube (1604), and the inert gas is injected via the first gas pathway (1602). Another end thereof is disposed in atmosphere pressure, and discharges the dry ice particles of inert gas (1605). Moreover, the dew-condensation prevention gas is injected from the second gas pathway (1603), and the dew-condensation prevention gas particles (1606) are discharged. The discharged dew-condensation prevention gas prevents dew-condensation. Moreover, as shown in Fig. 16, the abrasive (1607) is injected from the mid-body of the nozzle section. The injected abrasive is compressed and transported into inside of the nozzle by suction effect of negative pressure inside of the nozzle, attached to the surface of the dry ice particles of the inert gas before the discharging end of the nozzle section, and discharged therefrom. The abrasive particles (1608) are attached on the surface of the discharged dry ice particles of the inert gas, so that the discharged dry ice particles of the inert gas increase the physical strength thereof.

The abrasive storage section stores the abrasive. The abrasive is attached to the dry ice particles of the inert gas. The injected abrasive is intaken by the negative pressure inside the nozzle, attached to the surface of the dry ice particles of the inert gas in the portion short of the discharging end of the nozzle section, and discharged therefrom.

Examples of the abrasive include, but not limited to, diamond particles, silica, carbon nano-tubes, fullerene, and alumina.

Next, an operation process of said thin-film structure processing device will be described. The inert gas stored in said liquefied

high-pressure inert gas storage section arrives to the nozzle section via the connecting tube. The inert gas that has arrived to the nozzle section is disposed in atmosphere pressure of another end. At this point, the inert gas liquefied by high-pressure partially evaporates or solidifies as pressure drops to normal. The solidified inert gas becomes dry ice particles. At this point, the injected abrasive is attached on the surface of the dry ice particles of the inert gas by the negative pressure inside of the nozzle before the discharging end of the nozzle section.

By jetting the jet flow, including the dry ice particles to which the abrasive has been attached, to the thin-film structure, the uneven surface of the thin-film structure and the flare are processed. The abrasive particles are attached on the surface of the discharged dry ice particles of the inert gas, so that the discharged dry ice particles of the inert gas increase the physical strength thereof and also increase the impact strength thereof. Moreover, a grinding process with the use of abrasive is performed, thereby increasing the precision of surface roughness. Moreover, it enables cleaning with supercritical pressure cleaning.

The sixth embodiment of the present invention relates to the thin-film structure processing device of the fifth embodiment of the present invention wherein the abrasive, the particles diameter of which is 0.01 μm to 1μm, is used.

The other characteristics are the same as described in the fifth embodiment of the present invention.

The seventh embodiment of the present invention relates to the thin-film structure processing device of the fifth embodiment of the present invention wherein the abrasive is diamond particles.

The other characteristics are the same as described in the fifth embodiment of the present invention.

In addition to the processes as described in the first to the seventh embodiments, by changing the size or the flow rate of the dry ice particles, it becomes possible to form the jet flow strong enough for processing.

Moreover, by adjusting the clearance between the nozzle section and the holder, which holds the object of processing, it becomes possible to acquire sufficient impact strength at the point of impact between the nozzle and the object of processing.

Moreover, by changing the angle between the nozzle and the object of processing, it becomes effective for processing of the structure such as the flare as shown in Fig. 3.

As shown in Fig. 17, the thin-film structure processing device (1701), for processing a thin-film structure formed on a substrate comprises:

a liquefied high-pressure inert gas storage section (1702) storing the liquefied high-pressure inert gas,

a nozzle section (1703) for discharging liquefied inert gas stored by said liquefied high-pressure inert gas storage section into atmosphere pressure (1705), and jetting jet flow including dry ice particles of inert gas to said thin-film structure (1707), and

a thin-film structure holding section (1706) for holding said thin-film structure, and wherein said thin-film structure holding section holds an object plane of processing of said thin-film structure in an obliquely downward direction, and said nozzle section having the nozzle structure capable of forming the jet flow strong enough for grinding the thin-film composing said thin-film structure by jetting the jet flow of said inert gas to said object plane of processing thereof held in an obliquely downward direction by said thin-film structure holding section at any angle except perpendicular.

According to the present invention, the thin-film structure holding

section holds an object plane of processing of said thin-film structure in an obliquely downward direction, and said nozzle section jets the jet flow of said inert gas to said object plane of processing thereof held in an obliquely downward direction by said thin-film structure holding section at any angle except perpendicular, so that it becomes easy to remove the waste of grinding on the surface of the object of processing. The first reason why it is easy to remove the waste is that the waste removed from the surface of the object of processing naturally falls in a downward direction, due to gravity, so that it does not stay on the surface of the object of processing. The second reason is that the waste removed from the surface of the object of processing is easily spattered with the jet flow reflecting off the surface of the object plate of processing.

Moreover, as shown in Fig. 18, the thin-film structure processing device (1801) for processing a thin-film structure formed on a substrate comprises;

a liquefied high-pressure inert gas storage section (1802) storing the liquefied high-pressure inert gas,

a nozzle section (1803) for discharging liquefied inert gas stored by said liquefied high-pressure inert gas storage section into atmosphere pressure (1805), and jetting jet flow including dry ice particles of inert gas to said thin-film structure (1807), and

a thin-film structure holding section (1806) for holding said thin-film structure, and wherein said thin-film structure holding section holds an object plane of processing of said thin-film structure in a straight-down direction, and said nozzle section having the nozzle structure capable of forming the jet flow strong enough for grinding the thin-film composing said thin-film structure by jetting the jet flow of said inert gas to said object plane of processing thereof held in a straight-down direction by said

thin-film structure holding section at any angle except perpendicular.

As described hereinabove, the waste removed from the surface of the object of processing naturally falls in a downward direction due to gravity, and is easily spattered with the jet flow reflecting off the surface of the object plate of processing. Although the difference is that the direction is obliquely downward or straight-down, either direction may be selected depending on which is more effective either to remove the waste naturally by the gravity thereof or to remove it with the reflection of the jet flow.

Moreover, the thin-film structure processing device for processing a thin-film structure formed on a substrate comprises;

a liquefied high-pressure inert gas storage section storing the liquefied high-pressure inert gas,

a nozzle section for discharging liquefied inert gas stored by said liquefied high-pressure inert gas storage section into atmosphere pressure, and jetting jet flow including dry ice particles of inert gas to said thin-film structure, and

a thin-film structure holding section for holding said thin-film structure, and wherein said thin-film structure holding section holds an object plane of processing of said thin-film structure in an obliquely downward direction, and said nozzle section having the nozzle structure capable of forming the jet flow strong enough for grinding the thin-film composing said thin-film structure by jetting the jet flow of said inert gas to said object plane of processing thereof held in an obliquely downward direction by said thin-film structure holding section.

Furthermore, the thin-film structure processing device for processing a thin-film structure formed on a substrate comprises;

a liquefied high-pressure inert gas storage section storing the liquefied high-pressure inert gas,

a nozzle section for discharging liquefied inert gas stored by said liquefied high-pressure inert gas storage section into atmosphere pressure, and jetting jet flow including dry ice particles of inert gas to said thin-film structure, and

a thin-film structure holding section for holding said thin-film structure, and wherein said thin-film structure holding section holds an object plane of processing of said thin-film structure in a straight-down direction of, and said nozzle section having the nozzle structure capable of forming the jet flow strong enough for grinding the thin-film composing said thin-film structure by jetting the jet flow of said inert gas to said object plane of processing thereof held in a straight-down direction by said thin-film structure holding section.

According to the thin-film structure processing device of the present invention, the nozzle structure is capable of forming the jet flow strong enough for grinding the thin-film composing said thin-film structure by jetting the jet flow of said inert gas to the thin-film structure. Thereby it becomes usable not only to clean the waste but also to grind the uneven surface of the precision component such as semiconductor material and the flare solidly fixed to the base of the thin-film of the semiconductor material. Moreover, it is usable to remove extraneous on the surface of organic EL material or natural oxide film attaching to the surface of slider of GMR head. Therefore, it becomes able to share both devices for processing and cleaning, thereby reducing cost.

Moreover, according to the embodiments (e.g. the first embodiment) of the present invention, it becomes possible to remove the burr and the flare, which is about 50 Å to tens of μm, formed by etching or thin-film deposit (e.g. by plasma CVD, spattering, and ion deposition etc.), and the organic waste such as a photo resist etc. by the physical force of particles of dry

ice.

Moreover, according to the embodiments (e.g. the fifth embodiment) of the present invention, it becomes possible to remove the organic and the inorganic thin-film structure, which has been impossible by using the conventional device for grinding and cleaning. According to the fifth embodiment of the present invention, the dry ice to which the abrasive is attached is used for the thin-film structure removing process. By attaching the abrasive to dry ice, it becomes possible to remove the organic and the inorganic thin-film structure which had been impossible to remove by jetting with only dry ice.

Moreover, according to the first and the second embodiments of the present invention, by jetting the inert gas stored in a cylinder, which is separately prepared from the abrasive stored in another cylinder, in the form of liquid is jetted with the dry ice, it becomes possible to reduce the static electricity which is conventionally generated, thereby protecting the object of processing from destruction caused by the static electricity.